

***ROCKY FLATS ENVIRONMENTAL
TECHNOLOGY SITE (RFETS)***

***Site Beryllium Characterization
Sampling and Analysis Plan***

For:

Kaiser-Hill, LLC
Golden, CO

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Attachment 1 – Locations of Beryllium Areas (Historical and Present) and Locations of
Nonradioactive Areas.

Attachment 2 – Maps of Beryllium Areas and Layout of RFETS.

Attachment 3 – Standard Operating Procedures (SOPs).

Attachment 4 – Field Survey Forms.

Attachment 5 – Statistical Methods.

Attachment 6 – Homogeneous Sampling Areas Table.

1.0 INTRODUCTION

Radian Corporation (Radian) has been tasked by Kaiser-Hill Company, LLC (Kaiser-Hill) under Contract No. KH700068EP6 to conduct a site beryllium characterization at the Rocky Flat Environmental Technology Site (RFFETS). The objectives of the project are to 1) conduct an initial characterization of 35 buildings by collecting surface and air samples; 2) create a database with the data generated from the initial characterization of the 35 buildings; and 3) develop a Beryllium Management Plan based on the results of the initial characterization. The sampling and analysis for the initial characterization of the 35 buildings will be conducted in two phases. The first phase will include buildings 460, 123, and 881. The remaining buildings will be sampled in Phase 2. Upon completion of Phase 1 sampling and analysis, this SAP will be reviewed and modified if necessary, based upon the knowledge and experience gained in Phase 1. This document is the sampling and analysis plan (SAP) for the initial characterization of the 35 buildings.

1.1 Purpose

The purpose of this SAP is to 1) document the scientific rationale and methodologies for accomplishing the surface and air sampling and analysis; 2) direct the Radian field sampling teams in the collection of surface and air samples; and 3) document relevant quality assurance and quality control procedures for the sampling.

1.2 Organization

This document is organized so that essential information is included in the main body and detailed supporting information is provided in the attachments. There are six sections and five attachments to the SAP. Section 1 is this introduction. Section 2 provides relevant background information about the 35 buildings. Section 3 summarizes the data quality objectives (DQOs). Sections 4 and 5 describe surface and air sampling procedures and sample locations. Section 6

describes quality assurance and quality control requirements for the sampling and analysis.

Attachment 1 lists historical beryllium-related activities in the buildings and buildings deemed to be nonradioactive. Attachment 2 is a diagram of the Rocky Flats Plant. Attachment 3 is the standard operating procedures (SOPs) for sampling. Attachment 4 is the forms for sample collection. Attachment 5 details the statistical methods used for the project.

1.3 Definitions

Some essential definitions to aid in understanding the SAP include :

Biased Sample Location – an area within a homogeneous sampling area that has the greatest potential for harboring contamination.

Contamination – for the purposes of this project, contamination refers to the unwanted presence of beryllium particles on surfaces and/or in the air in quantities that exceed established criteria.

Data quality objectives (DQOs) – Qualitative and quantitative statements of the overall level of uncertainty that a decision-maker is willing to accept in results or decisions derived from environmental data. DQOs provide the statistical framework for planning and managing environmental data operations consistent with the data user's needs.¹

Frequency of Concern – the rate at which a characteristic occurs in a given population, stated as a percent. In this case, the frequency at which beryllium contamination occurs in a building.

¹Reference – Federal Register, Volume 57, Number 104, May 29, 1992, Part VI, Environmental Protection Agency (EPA), pp. 22888 22938, Guidelines for Exposure Assessments; Notice.

Homogeneous sampling area (HSA) – a structural building component or system that is uniform with regard to use, type, age, and location such that a sample collected from one location in the HSA is representative of the remaining areas.

2.0 BACKGROUND

The 35 buildings to be characterized have had a variety of historical uses. Attachment 1 provides a list beryllium-related activities in the buildings along with a list of nonradioactive buildings. Attachment 2 shows their location on a RFETS map. The potential for beryllium contamination is believed to be dependent on the quantity of beryllium handled in the building, the time period that beryllium was handled, procedures followed when handling beryllium, the type of beryllium processing conducted, available engineering controls, and locations within the building where beryllium was handled. While it is beyond the scope of this characterization project, it is noted that radioactive (RAD) material was handled in many of the same areas where beryllium was processed. Because of this, radiological control procedures are a part of this SAP.

Based on the variables described in the above paragraph, the 35 buildings can be qualitatively grouped into categories describing the likelihood of contamination. Intuitively, those buildings where beryllium was not processed (e.g., vehicle garage, offices, non-beryllium processing areas) should have a low probability of contamination. Buildings where beryllium was handled in small quantities in a non-destructive manner (e.g., laboratories, laundry, storage) should have a medium probability of being contaminated, and buildings where beryllium was handled in large quantities in a destructive manner (e.g., machining) should have a high probability of contamination.

The likelihood that there is contamination in a particular room in a building is believed to be dependent on the overall probability of contamination in that building, recognizing that ventilation system design (e.g., common air plenums) and administrative procedures (e.g., restricting beryllium worker mobility) can also be influential. Therefore, the building background information presented here includes a description of the rooms, ventilation systems, access restrictions, and beryllium processing conducted. In addition, we have qualitatively

grouped the buildings into probable contamination categories of high, medium, and low and have provided a relative estimate of the building size (small, medium, large). Significantly more building information will be obtained prior to sample collection.

Table 2.1 lists the 35 buildings included in the initial characterization.

6.

Table 2.1 - Descriptions of 35 Buildings in the RFETS Initial Site Beryllium Characterization

Number	Function	Relative Size	Probability of Contamination	Comments
331	Fire Station	Medium	Low	Has a garage. Previously housed metallurgical operations.
371	Plutonium Processing	Large	Low	Large building. Performed non-destructive assay.
374	Plutonium Processing	Large	Low	Large building contiguous with 371. Conducted waste processing.
441	Administration	Large	Low	Currently used for administration; previously used as analytical laboratory for beryllium.
442	Filter Testing	Medium	Low	Also housed laundry facility.
460	Machining (Stainless Steel)	Medium	Low	Machined beryllium-copper alloy in high bay area.
771	Plutonium Processing	Medium	Low	No known use of beryllium in this building. Conducted x-ray analysis.
123	Laboratory	Medium	Medium	Some labs in this building performed beryllium analysis. Testing of air filters. environmental samples, biological samples.
559	Laboratory	Medium	Medium	Plutonium and other radionuclide analysis. Beryllium standards were stored here.
795	Laboratory	Small	Medium	Small building where various beryllium coatings were tested and analyzed in a laboratory.
774	Waste Treatment	Small	Medium	Small building used for treating liquid waste.
778	Laundry	Medium	Medium	Beryllium contaminated clothing was laundered here.
779	Research and Development	Medium	Medium	Conducted machining and some beryllium processing.
789		Medium	Medium	Currently used for waste storage and treatment. Was used for processing concrete.

Table 2.1 - Descriptions of 35 Buildings in the RFETS Initial Site Beryllium Characterization

Building Number	Function	Relative Size	Probability of Contamination	Comments
881	Laboratory	Large	Medium	Large building, multiple labs.
881F	Utility Building	Small	Medium	Small building that contains the air plenum for Building 881. Beryllium contaminated air may be in exhaust ventilation system.
985	Utility Building	Small	Medium	Contains plenum for Buildings 996, 997, 999. Beryllium contamination may be in exhaust ventilation system.
991	Warehouse	Large	Medium	Main storage warehouse for finished products containing beryllium.
750	Pad	Medium	Medium	Waste storage area with temporary cover. Waste containers closed. Beryllium waste stored here. Spills could have spread beryllium contamination.
904	Pad	Medium	Medium	Waste storage pad similar to 750.
207	Ponds	Medium	Medium	Five solar evaporation ponds for settling solids. Now empty. Beryllium contaminated waste may have been treated here.
444	Beryllium Processing	Large	High	Main beryllium processing building.
447	Beryllium Processing	Large	High	Contiguous with 444.
448	Beryllium Processing	Large	High	Contiguous with 444 and 447.
450	Filter Building	Small	High	Small utility building that contains HEPA filters for 444, 447, and 448.
451	Filter Building	Small	High	Similar to 450; contains HEPA filters for 444, 447, and 448.
452F	Laboratory	Small	High	Small building with a laboratory used for beryllium exposure experiments.

Table 2.1 – Descriptions of 35 Buildings in the RFETS Initial Site Beryllium Characterization

Number	Function	Relative Size	Probability of Contamination	Comments
455	Filter Building	Small	High	Similar to 450; contains HEPA filters for 444, 447, and 448.
707	Beryllium Processing	Large	High	Large building where beryllium processing (machining) occurred within a few small modules.
777	Manufacturing	Large	High	Main manufacturing building.
865	Beryllium Foundry	Large	High	Large building containing the foundry for beryllium processing. Beryllium machining was also conducted here.
867	Filter Building	Small	High	Small utility building containing HEPA filters for exhaust from 865.
868	Filter Building	Small	High	Similar to 867; contains HEPA filters for 865.
879	Filter Building	Small	High	Small utility building; contains HEPA filters for 883.
883	Beryllium Processing	Medium	High	Major processing (rolling and forming) of beryllium occurred here.

3.0 DATA QUALITY OBJECTIVES

Radian has used the DQO process to clarify the objectives of the initial site beryllium characterization. This systematic analysis has helped define the end products desired by Kaiser-Hill. In this section, a summary of the process is provided. The Radian developed software DQO-PRO was used to assist in this process. Information on DQO-PRO is provided in Attachment 5.

The DQO process consists of seven steps. These steps are listed below and are the subsection headings for the remainder of this section.

1. State the problem,
2. Identify decisions needed to solve the problem,
3. Identify inputs to the decision,
4. Define the boundaries,
5. Develop decision rules,
6. Specify limits on the decision error, and
7. Optimize design for collecting data.

3.1 State the Problem

The fundamental problem is that beryllium-related disease has and is still occurring in the population of current and former workers at RFETS. To help mitigate this outbreak, a better understanding of the locations, quantities, and physical characteristics of beryllium contamination is desired.

3.2 Identify Decisions Needed To Solve The Problem

Decisions needed to solve the problem include:

1. What buildings have contamination and what are the levels?
2. If a building has contamination, where is it found?
3. Is the contamination airborne and/or on surfaces?
4. Is the contamination of a particle size that can be inhaled into the lungs?
5. What personnel restrictions are needed to control access to contaminated building areas?
6. What engineering controls can be used to control exposure to contamination?
7. What are appropriate levels of personal protective equipment (PPE) for people working in buildings with contamination?
8. What are appropriate methods for surveying potentially contaminated equipment before it is released to the public?
9. How can exposure be best controlled during the decontamination and decommissioning (D&D) of buildings?
10. How can beryllium waste streams be best managed to control exposure?

The data collected from the initial characterization of 35 buildings will provide Kaiser-Hill with current and relevant information to aid in making these decisions. However, the data will not be sufficient to fully answer every one of these questions. It is anticipated that the initial characterization study will provide sufficient information to answer many of the questions and provide guidance for further, more detailed, characterization studies such as those typically conducted prior to the D&D of a building.

3.3 Identify Inputs to the Decision

This section identifies information that is available and either has been or will be used to make decisions about sampling. Where there are information gaps, we will consult with Kaiser-

Hill's Contract Technical Representative (CTR) for guidance. Types of information that are valuable for making sampling decisions include:

- ▶ Process knowledge (past and present);
- ▶ Work locations of personnel who have chronic beryllium disease (CBD) or are sensitized to beryllium;
- ▶ Visual observations;
- ▶ Building drawings (e.g., ventilation systems);
- ▶ Personnel interviews;
- ▶ Building inspections;
- ▶ Historical data and reports;
- ▶ Anecdotal reports of work practices; and
- ▶ Current and past operating procedures.

These information sources are useful in predicting locations where beryllium contamination may be present.

3.4 Define The Boundaries

The physical boundary for this project is the 35 buildings at RFETS described in Radian's scope of work and in Table 2.1. Items outside the building envelope, such as external roof surfaces and walkways, are out of scope. All building systems, components, and equipment within a building's envelope are within the boundaries of this project (unless specifically excluded by the CTR). This includes, but is not limited to:

- ▶ Process equipment (mills, presses, furnaces, glove boxes, lab hoods, blowers, and compressors);
- ▶ External surfaces of miscellaneous materials and equipment (storage cabinets, shelves, counter tops, furniture);

- ▶ Building infrastructure (plumbing, electrical, ventilation systems, steam and condensate system, cooling system, gas systems); and
- ▶ Floors, walls, and ceiling (including supporting structures).

The boundary for air sampling is the atmosphere within the building envelope. Outside ambient air may be tested as necessary to establish background levels of beryllium.

The boundary for surface sampling is that dirt and dust that is removable by hand pressure from the above described building systems, components, and equipment.

3.5 Develop Decision Rules

The decision rules are applied to the collected data to answer the questions expressed in section 2.2. For this project the relevant standards to which data will be compared are the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) for airborne concentrations of beryllium, the RFETS action level for airborne concentrations of beryllium, and the RFETS recommended release criteria for surface beryllium contamination.

The ACGIH TLVs for airborne beryllium are^{2, 3}:

1. 2 micrograms per cubic meter of air ($\mu\text{g}/\text{m}^3$) for an 8 hour time-weighted average (TLV-TWA), and;
2. 10 $\mu\text{g}/\text{m}^3$ for a 15 minute time-weighted average (TLV-STEL).

²American Conference of Governmental Industrial Hygienists, 1996 TLVs and BEIs, Threshold Limit Values for Chemical Substances and Physical Agents, Biological Exposure Indices.

³American Conference of Governmental Industrial Hygienists, 1996 Annual Report, Page 2, Transfers to the Adopted List for 1997.

In addition, RFETS applies an administrative action level of $0.5 \mu\text{g}/\text{m}^3$ of beryllium for an 8 hour time-weighted average.

The RFETS recommended release criteria for surface beryllium contamination is 9 micrograms per square foot ($\mu\text{g}/\text{ft}^2$).

Individual air and surface wipe samples that exceed these respective values will indicate that contamination is present. Conversely, individual results that indicate concentrations are below these criteria will indicate that contamination is not present. Statistical methods will be employed to evaluate the acceptability of multiple data points.

Particle size distribution results from surface dust samples will be compared to the ACGIH particle aerodynamic diameters used in the calculation of particle size selective TLVs². They are:

1. 100 microns = inhalable
2. 25 microns = thoracic
3. 10 microns = respirable

The particle size distribution, combined with the beryllium mass concentration will be combined to provide a relative measure of the potential inhalation hazard of surface dust.

3.6 Specify Limits On Decision Error

A decision error of 5 percent has been selected. This means that conclusions can be stated with 95 percent confidence. The allowed decision error is based on the potential for contamination in an HSA within one or more buildings. Buildings are divided into HSAs to help differentiate between clean and contaminated areas. Further discussion on HSAs is provided in Section 3.7.2.

Three frequencies of concern have been selected, 5, 10, and 25 percent. A 5 percent frequency of concern will be applied to HSAs that are *assumed clean*. A more detailed discussion of how this and other building categories are derived is in Section 3.7.1. It is in these *assumed clean* HSAs that we are attempting to demonstrate that they are not contaminated with beryllium. If results from samples collected in these HSAs indicate beryllium contamination is not present, then the following conclusion could be drawn:

"We are 95 percent confident that 95 percent or more of the *assumed clean* HSAs are free from beryllium contamination."

If results from samples collected in the *assumed clean* HSAs indicate beryllium contamination is present, then the following statement would apply:

"We are 95 percent confident that more than 5 percent of the *assumed clean* HSAs have beryllium contamination."

A 10 percent frequency of concern will be applied to HSAs that are *probably clean or possibly contaminated*. In these HSAs there is less certainty about the presence of contamination prior to field sampling. The fact that there are two categories indicates that there is reason to lean one way or the other. But, until some data is collected, it is difficult to make an accurate judgment about beryllium contamination. The initial characterization will help define contamination in these HSAs and lead to a more certain classification.

If results from samples collected in these buildings indicate beryllium contamination is present, then the following statement would apply:

"We are 95 percent confident that more than 10 percent of the HSAs have beryllium contamination."

If results from samples collected in these HSAs indicate beryllium contamination is not present, then the following conclusion could be drawn:

"We are 95 percent confident that 90 percent or more of the HSAs are free from beryllium contamination."

At that point, it may be desirable to collect additional samples so that a 5 percent frequency of concern conclusion could be reached.

A 25 percent frequency of concern will be applied to HSAs that are *probably contaminated*. It is in these HSAs that we are attempting to demonstrate that they are contaminated with beryllium. If the results from samples collected indicate that beryllium contamination is present, then the following conclusion could be stated:

"We are 95 percent confident that more than 25 percent of the HSAs have beryllium contamination."

If results from samples collected in the building indicate beryllium contamination is not present, then the following statement would apply:

"We are 95 percent confident that more than 75 percent of the HSAs are free from beryllium contamination."

A lower frequency of concern is desired for determining whether contamination is not present because if the wrong conclusion is drawn, workers could be over exposed to beryllium. If an area is declared free from contamination, access to the area may be less restricted, work control procedures may be less stringent, engineering controls may be relaxed, and workers may not wear sufficient PPE. If this occurs and contamination is actually present, the potential for

worker exposure is unacceptably high. This is clearly a scenario to avoid and is a "false-negative", or saying contamination is not present when it really is. Thus, it must be with a high degree of confidence that a building or area within a building is declared not contaminated.

When making the reverse judgement, that a building or area is contaminated, a higher frequency of concern is acceptable for the following reasons. First, there is substantial historical information that indicates that several of the buildings have housed extensive beryllium operations over the years. These buildings can be reasonably assumed to be contaminated to some extent. It is simply a question of how much and the exact locations of the contamination in the building. Surface and air samples in these buildings are simply expected to confirm what is already known or suspected. Second, if a decision error is made (an uncontaminated area declared contaminated or "false-positive") workers will still be protected from exposure to beryllium. Work practice controls, engineering controls, and PPE will be continued (possibly unnecessarily) but workers will not be over exposed to beryllium because of the judgement error.

3.7 Optimize Design For Collecting Data

This section integrates all of the previous requirements specified in the DQO process so that Radian can most effectively collect data to fulfill the study objectives. Buildings and building areas have been categorized *a priori* so that logical hypotheses can be stated about building contamination. Following is a discussion of the categories and how they lead to sample collection decisions.

3.7.1 Categorizing Buildings

The buildings may be divided into four categories based on information gathered through those items listed in Section 3.3 (e.g., interviews, historical documents, drawings). These strata are: *assumed clean, probably clean, possibly contaminated, and probably contaminated.*

Individual buildings have been placed into one of these categories because of the probability that one or more areas within that building are contaminated. *Assumed clean* buildings have rooms and hallways where beryllium processing was never conducted, air spaces and ventilation systems are not shared with rooms used for beryllium processing, beryllium workers did not visit unless fully decontaminated, and no other contamination routes are known. In these areas, a low probability of contamination is expected. *Probably clean* buildings have rooms and hallways where beryllium processing was never conducted but the possibility for cross contamination from beryllium areas exists through shared air spaces, shared ventilation systems, and transfer of contamination by beryllium workers. In these areas, a medium probability of contamination is expected. *Possibly contaminated* buildings have rooms and hallways that appear to have a direct connection to a beryllium processing area, or where only small quantities of beryllium were handled (e.g., laboratory performing beryllium analyses). A high probability of contamination is expected. *Probably contaminated* buildings have rooms and hallways where beryllium processing was conducted and the probability of finding contamination is very high.

3.7.2 Categorizing Areas Within a Building

Just as an entire building has been placed into a contamination category, areas within a building can be similarly categorized. These are called homogeneous sampling areas (HSAs). This concept is based on the strategy for inspecting and managing asbestos-containing materials specified in the Asbestos Hazard and Emergency Response Act. Radian has modified this concept and applied it when characterizing buildings with contaminants other than asbestos, in this case, beryllium. Typical HSAs include but are not limited to:

- ▶ Floors;
- ▶ Ceiling tiles;
- ▶ Process equipment (e.g., lathes, milling machinery, etc);
- ▶ Internal areas of storage equipment (shelves, cabinets, desks, etc.);

- ▶ Heating, ventilating, and air conditioning (HVAC) systems;
- ▶ Local exhaust ventilation systems; and
- ▶ Miscellaneous horizontal surfaces (window sills, tops of equipment, light fixtures, etc.).

Surface wipe samples are collected from HSAs to indicate whether beryllium contamination is present. Inferences about the entire HSA are based on the sample results.

3.7.3 Surface Sampling

The number of surface samples in a building is determined by the number of different HSAs within that building and the frequency of concern. The location of samples within an HSA is determined by a non-random (biased) sampling scheme.

A biased sampling scheme is preferred when attempting to demonstrate that contamination is not present. This allows the sampling team to test the locations where contamination is most likely to occur. If it is not present there, then it is reasonable to assume that it not present at other, less likely, locations either. If a random sampling strategy were to be applied, there is some probability that contamination would not be detected because the randomly selected locations did not include an area where dust collects. For example, when sampling the surface of a light fixture, a biased sample location would be the dustiest square foot on top of the fixture (where dust settles and people rarely clean). A random sample might turn out to be a square foot on the underneath side where dust does not collect. Coupled with the logic described in Section 3.6 on decision error, a biased sampling approach strengthens the conclusion that contamination is not present.

The equation used to calculate the number of biased samples to be collected within an HSA will depend on the frequency of concern selected. If the frequency of concern is less than 10%, then the number of samples required may be based on the following equation:

$$n = \frac{\ln(1-p)}{\ln(1-Y)}$$

where:

n = required number of samples

p = desired confidence level (i.e., 0.95)

Y = frequency of concern (i.e., 0.05)

\ln = symbol for taking the natural logarithm

The resultant from this equation " n " will be the number of samples required from each HSA within each building categorization (i.e., assumed clean, probably clean, possibly contaminated, and probably contaminated). If the frequency of concern is established at 5% and the confidence level is 95%, then n equals 59. If 15 buildings with areas assumed clean are identified, then the average number of samples to be collected from each building from an "assumed clean" HSA is:

$$(\text{number of samples per HSA per building}) = n / (\text{number of buildings}) = 59/15 = 4.$$

If during the course of sampling a positive sample is found within an assumed clean area, then the true confidence level for the original assumption (i.e., assumed clean areas really are clean) may be recalculated. In the example above, the confidence level would be reduced from 95% to 81% if one of the 59 samples was positive. That is, it could be stated that at least 5% of the areas are contaminated with 81% confidence.

If the frequency of concern is greater than 10% then a different equation is used. This equation must be solved iteratively:

$$1 - p = \frac{n!}{r!(n-r)!q(n-r)^r Y^r}$$

where:

n = number of samples to be collected

p = desired confidence level (0.95)

r = number of samples with the characteristic to be detected (1)

Y = the percentage of the population with the characteristic or frequency of concern
(0.25)

q = percentage of the population without the characteristic (1- Y)

If the frequency of concern is established at 25% and the confidence level is 95%, then the number of samples required " n " is 11. If 15 buildings have areas identified as probably contaminated, then the average number of samples to be collected from each building from each "probably contaminated" HSA would be:

$$(\text{number of samples per building}) = n / (\text{number of buildings}) = 11/15 = 1.$$

Attachment 5 provides a reference and more detailed description of the statistical methods.

Based on this analysis, the number of wipe samples to be collected from each HSA are described in Table 3.1. Attachment 6 is a spreadsheet indicating how the Number of HSAs were calculated.

Table 3.1 Preliminary Estimate of Surface Wipe Samples

HSA	Frequency of Concern	Area Status	No. Of Buildings	No. Of Sample Locations per Building (n)	Total No. Samples (N)
Floor	5%	Assumed Clean	18	3	54
Ceiling Tile	5%	Assumed Clean	15	4	60
Process Equipment	5%	Assumed Clean	16	4	64
Internal Areas	5%	Assumed Clean	15	4	60
Supply Ventilation	5%	Assumed Clean	18	3	54
Exhaust Ventilation	5%	Assumed Clean	0	0	0
Misc. Horizontal Surfaces	5%	Assumed Clean	19	3	57
Floor	10%	Probably Clean	29	1	29
Ceiling Tile	10%	Probably Clean	24	1	24
Process Equipment	10%	Probably Clean	25	1	25
Internal Areas	10%	Probably Clean	23	1	23
Supply Ventilation	10%	Probably Clean	26	1	26
Exhaust Ventilation	10%	Probably Clean	17	2	34
Misc. Horizontal Surfaces	10%	Probably Clean	36	1	36
Floor	10%	Possibly Contaminated	28	1	28
Ceiling Tile	10%	Possibly Contaminated	15	2	30
Process Equipment	10%	Possibly Contaminated	24	1	24
Internal Areas	10%	Possibly Contaminated	13	2	26
Supply Ventilation	10%	Possibly Contaminated	9	3	27
Exhaust Ventilation	10%	Possibly Contaminated	32	1	32
Misc. Horizontal Surfaces	10%	Possibly Contaminated	32	1	32
Floor	25%	Probably Contaminated	15	1	15
Ceiling Tile	25%	Probably Contaminated	9	1	9
Process Equipment	25%	Probably Contaminated	10	1	10
Internal Areas	25%	Probably Contaminated	10	1	10
Supply Ventilation	25%	Probably Contaminated	0	0	0
Exhaust Ventilation	25%	Probably Contaminated	18	1	18
Misc. Horizontal Surfaces	25%	Probably Contaminated	17	1	17
Number of Surface Samples					824

3.7.4 Air Sampling

This section describes the strategy for collecting air samples. Detailed methods and procedures are included in Section 5 and the attachments. Air samples will be collected for 3 reasons: 1) the results are a closer indicator of worker inhalation exposure potential than surface wipe samples; 2) the results may be directly compared to compliance standards; and, 3) they may indicate the presence of small beryllium particles in the air that will not settle onto surfaces and would not be detected by surface wipe samples. When combined with surface wipe sampling results, air sample results provide additional insight into the presence or absence of contamination in a building. Surface wipe results are an indicator of contamination that can potentially become airborne while air sample results indicate contamination that is currently airborne and could be inhaled by individuals. Following are details of the area and personal breathing zone air sampling plan.

Area Air Samples

A sufficient number of area samples will be collected so that descriptive and inferential statistics can be calculated for the data set. Statistics of interest include, but are not limited to, the average (mean) concentrations, variability (standard deviation), confidence limits around the mean, and the upper tolerance limit. Following is a description of the area air sampling strategy. The strategy may be adjusted once buildings are inspected. Such adjustments will be documented through a Field Change Request form approved by the Radian project manager and, if necessary, the Contract Technical Representative (CTR).

The 35 buildings are divided into three qualitative size categories (small, medium, and large) in Table 1.1. The estimated number of area air samples is based on this relative assessment of each building's relative size. That is, the bigger the building, the greater the number of samples. For small buildings 3 sample locations will be selected, medium size buildings will have 5 locations, and large buildings will have 8 locations. These locations will be selected by the field team leader.

When there are multiple HVAC systems in a building, an attempt will be made to select one sample location for each HVAC system. When a building has a combination of *assumed clean, probably clean, possibly contaminated, and probably contaminated* areas, an attempt will be made to collect an area air sample in each category.

Two area air samples will be collected from each location in a building. The preferred periods will be one sample collected in the morning and one sample collected in the afternoon. Two samples collected in series (back-to-back) should be avoided when possible. Sample duration will be approximately one hour.

Table 3.2 lists the anticipated number of area air samples per building.

Table 3.2 Area Air Sampling Strategy

Building Number	Relative Size	No. Of Area Air Sampling Locations	No. of Samples per Location	No. Of Background Samples	Total No. Of Area Air Samples
331	Medium	5	2	1	11
371	Large	8	2	1	17
374	Large	8	2	1	17
441	Large	8	2	1	17
442	Medium	5	2	1	11
460	Medium	5	2	1	11
771	Medium	5	2	1	11
123	Medium	5	2	1	11
559	Medium	5	2	1	11
705	Small	3	2	1	7
774	Small	3	2	1	7
778	Medium	5	2	1	11
779	Medium	5	2	1	11
788	Medium	5	2	1	11
881	Large	8	2	1	17
881F	Small	3	2	1	7
985	Small	3	2	1	7
991	Large	8	2	1	17
750	Medium	5	2	1	11
904	Medium	5	2	1	11
207	Medium	5	2	1	11
444	Large	8	2	1	17
447	Large	8	2	1	17
448	Large	8	2	1	17
450	Small	3	2	1	7
451	Small	3	2	1	7

Building Number	Relative Size	No. Of Area Air Sampling Locations	No. of Samples per Location	No. Of Background Samples	Total No. Of Area Air Samples
452F	Small	3	2	1	7
455	Small	3	2	1	7
707	Large	8	2	1	17
777	Large	8	2	1	17
865	Large	8	2	1	17
867	Small	3	2	1	7
868	Small	3	2	1	7
879	Small	3	2	1	7
883	Medium	5	2	1	11
TOTAL		186	-	35	407

Personal Breathing Zone Samples

Personal breathing zone air samples will be collected for two reasons: 1) to more closely estimate the concentration of beryllium in the breathing zones of workers in the 35 buildings than is possible with area samples, and 2) to describe breathing zone concentrations for workers as they perform specific tasks.

One hundred personal breathing zone samples will be collected over an 8-hour period from selected workers within the 35 buildings. Worker selection will be stratified-random. Workers in buildings that are *probably contaminated* are routinely monitored as part of the RFETS Beryllium Control Program. Additional samples on this population would provide little new knowledge. Instead, personal breathing zone sampling will be focused on workers that are not subjected to routine beryllium monitoring.

The approximate number of workers in each of the 35 buildings will be obtained. The total number of workers residing in the buildings will be calculated and the percent determined.

This percentage will then be multiplied by 100 to determine the number of samples to collect in that building. For example:

Building X has 25 workers. The total number of workers in all buildings is 1,500. The per cent of workers in Building X is $25/1,500$ or 1.67%. Rounding upward, this means that personal breathing zone samples from 2 randomly selected workers would be collected from the population of 25 workers in Building X.

This sample size calculation will be completed when building population data is obtained.

Approximately 20 personal breathing zone samples will also be collected on workers performing specific tasks such as decontaminating a piece of equipment prior to resale. This number is dependent on the frequency of tasks performed and the ability to coordinate the sampling with other project tasks. Radian will rely on the CTR to help identify these tasks. To the extent possible, these samples will be collected in conjunction with other sampling in that building.

Particle Size-Selective Sampling

Particle size-selective sampling will be conducted to 1) determine if beryllium particles less than 0.5 micron in diameter are present, and 2) estimate the particle size distribution of settled dust. This is a diagnostic sampling effort and therefore no attempt will be made to randomly sample. Rather, tasks with anticipated high concentrations of airborne beryllium will be sampled using a Marple Personal Cascade Impactor. Gravimetric and ICP/MS analysis will be conducted on the collected sample. A second approach will be to collect settled dust samples by vacuuming with a high-volume pump with an attached 37 mm cassette (open-faced). Analysis will be by phase contrast microscopy and ICP-MS. Up to 10 particle size selective samples will be collected. Because of the experimental nature of this task, the procedures and strategy may be revised upon further investigation.

4.0 SURFACE SAMPLING PROCEDURE

The purpose of this section is to specify the procedures for identifying sample locations within a building and collecting surface wipe samples at those selected locations. The procedure is organized into 5 steps: 1) collect building information, 2) identify HSAs, 3) identify sample locations, 4) collect the sample, and 5) submit the sample for analysis. Four forms to accomplish this are included in Attachment 4. They are "Building Evaluation Checklist", "Field Change Request Form", "Wipe Sample Collection Log", and "Chain-of-custody".

4.1 Collect Building Information

Before any samples can be collected, knowledge of the building structure and function is required. Using a set of building drawings and the Building Evaluation Checklist, the field team leader will walk through a building and collect the information specified on the form. The form will be attached to a copy of the floor plan.

4.2 Identify Homogeneous Sampling Areas

The strategy in Section 3 identifies 7 HSAs for this project. They are:

- ▶ Floors;
- ▶ Ceiling tiles;
- ▶ Process equipment;
- ▶ Internal areas of storage equipment;
- ▶ HVAC systems;
- ▶ Local exhaust ventilation systems; and
- ▶ Miscellaneous horizontal surfaces.

These HSAs must be placed into one of the following categories: *assumed clean*, *probably clean*, *possibly contaminated*, or *probably contaminated*. This stratification will be

based on process knowledge, analysis of building systems and architecture, visual observations, personnel interviews, locations where workers have developed CBD, and any other information deemed pertinent. It will be the combined responsibility of the field team leader and project engineer to make these determinations. It is expected that all four types of areas may be found in some of the buildings.

If an additional HSA is needed, a field change request will be submitted to the project manager for review and approval. It is preferred that the field change request be approved prior to sample collection; however, the field team leader has the latitude to collect the sample prior to approval in order to expedite sampling. Initial approval may be issued verbally. Either way, a field change request form will be completed and approved prior to sample analysis.

4.3 Identify Sample Locations

Potential sample locations will be identified and counted within each HSA by the field team leader, who will consult the project engineer as needed. A sample location is defined as an area within an HSA that has the greatest potential for harboring contamination. This is also referred to as a biased sampling location. Examples of potential biased sample locations include but are not limited to:

<u>HSA</u>	<u>Biased Sample Location</u>
Floor	Corner of room where dust accumulates Under an object not routinely cleaned Traffic area traversed by beryllium workers Adjacent to equipment associated with beryllium
Ceiling	On top surface above beryllium processing area
Tile	On top surface of frame On top surface where dust accumulation is noted Adjacent to exhaust ventilation system Adjacent to supply ventilation system
Process	On top surfaces where dust accumulation is noted

Equipment	On hidden surfaces not routinely cleaned On internal components Oily areas where dust tends to cling
Internal Areas	Back of shelf area Under cabinet drawer Back of cabinet shelf Internal parts of non-process equipment
HVAC System	Dead areas where dust tends to accumulate On access flanges where dust accumulates On upper surfaces of vent louvers At intakes potentially impacted by other exhausts Within plenum where dust accumulates Oily areas within plenum Oily areas associated with motor and/or blower
Local Exhaust Ventilation Systems	Dead areas where dust tends to accumulate On access flanges where dust accumulates On upper surfaces of vent louvers Downstream of filter where dust accumulates Within plenum where dust accumulates Oily areas within plenum Oily areas associated with motor and/or blower
Misc. Horizontal Surfaces	Door jams Elevated window sills On top of light fixtures On top of duct work (external) On top of piping, bus bars and other building components On top of girders and other structural members

Using the drawings and observations, the number of biased sample locations for each HSA will be counted and documented on the Building Evaluation Checklist.

By referring to Table 3.1, the number of samples to be collected for each HSA will be determined. This can be found in the column titled "No. Of Sample Locations per Building (n)". These are the number of locations that will be selected from the total number of sample locations

that were counted in the previous step. If more sample locations are believed to be needed, the field team leader should consult with the project engineer and prepare a "Field Change Request" and submit it to the project manager for review and approval.

4.4 Collect the Samples

Surface wipe samples (also called smear samples) will be collected in accordance with *Beryllium Control Program*, 4-15321-IHPM-5.2, *Rocky Flats Industrial Hygiene Procedures Manual*. All cited SOPs are in Attachment 3. Field data will be recorded on the "Wipe Sample Collection Log". These sample forms will be maintained in bound logbooks that will remain with the sampling team during sampling activities.

The sample procedure requires that removable contamination be wiped from a 1-ft² area. Two sizes of disposable surface area templates will be provided (1-ft² and a 100-cm²). In some situations the sample location selected may not allow for wiping an area as large as 1-ft². If this is the case, a 100-cm² area may be sampled. It is preferred that the surface area sampled be either 1-ft² or 100-cm². If in the judgment of the field team leader a different surface area is necessary, it is allowable as long as the new surface area is measured and recorded. However, any deviations from the standard collection procedure deemed necessary by the field team leader must be entered into the field logbook along with an explanation of why it was necessary.

If the sample is being collected in a RAD contamination control area, the sample location will be surveyed for RAD contamination prior to collecting the wipe sample. The survey will be conducted by a RCT provided by Kaiser-Hill. If the location is found to be radioactively contaminated, an equivalent nearby sampling location that is not radioactively contaminated will be sampled. If a nearby location cannot be identified the sample may be collected; however, the sample will be handled in accordance with RFETS radiation control procedure specified by the RCT.

Sample preservation and container selection will be conducted in accordance with TP-ESP-701, *Sample Preservation and Container Materials*. Samples will be placed in plastic petri dishes, sealed with tape, labeled, and placed into a sealable plastic bag for shipment or delivery to the onsite laboratory. (Note: The RFETS Beryllium Control Program, Smear Sample Procedure 4-15310-IHPM-5.2, requires that samples be placed in glassine bags. We are modifying that procedure and will be placing samples in petri dishes, because in our experience petri dishes maintain filter integrity better.)

Each sample will be clearly labeled. The label will include a unique sample identification number (which will also be recorded in the sample logbook), the sampler's initials, the time and date of sample collection, and the analysis requested. Further information will not be placed on the label to minimize the laboratory's knowledge regarding the type/location of the sample. Pre-printed labels will be provided. After labeling, the petri dish will be sealed with electrical tape, and placed into a plastic sample cooler. At the end of the day, the cooler will be sealed with evidence tape and carried to the onsite laboratory. Chain-of-custody (COC) protocol will be followed in accordance with TP-ESP-501, *Manual Chain-of-Custody*.

4.5 Submit the Samples for Analysis

Samples will be submitted to the RFETS onsite laboratory at the end of each day. The field team leader is responsible for submitting the samples. The samples will be considered released to the laboratory when the COC form is signed and the cooler relinquished. The field team leader will keep a copy of the COC form after submittal. If samples cannot be submitted on the day of collection, the field team leader will maintain possession and control until they can be submitted.

5.0 AIR SAMPLING PROCEDURES

The purpose of this section is to specify the procedures for collecting air samples. The procedure is organized into 5 steps: 1) collect building and occupant information, 2) identify area air sample locations, 3) identify personnel on which breathing zone samples will be collected, 4) identify tasks during which air samples will be collected, 5) collect the air samples, and, 6) submit the samples for analysis. Four forms to accomplish this are included in attachment 4. They are "Building Evaluation Checklist", "Field Change Request Form", "Air Sampling Field Data Sheet", and "Chain-of-Custody".

5.1 Collect Building and Occupant Information

Before any samples can be collected, knowledge of the building structure, function, and occupancy is required. Using a set of building drawings and the Building Evaluation Checklist, the field team leader will walk through a building and collect the information specified on the form. The form will be attached to a copy of the floor plan.

5.2 Identify Area Air Sample Locations

The relative size of the building (small, medium, or large) will be determined from Table 3.2. This classification will be validated by comparing it to the Building Evaluation Checklist. Using the same table, the number of sample locations for the building will be identified. The number of HVAC systems in the building will be counted and identified as *assumed clean*, *probably clean*, *possibly contaminated*, or *probably contaminated* (from the Building Evaluation Checklist). A sample location will then be selected from within the area serviced by each HVAC system. If there are more HVAC systems than sample locations, locations where the HVAC has a higher probability of contamination will be selected. The sample location will be marked on a building diagram and labeled as area air sample location #1, #2, etc.

All of the air sampling locations will be inspected, and a specific place to put the air sampling pump will be identified. The sampling location should:

- ▶ Be accessible to the field team;
- ▶ Not be subject to vandalism or tampering;
- ▶ Allow the filter cassette to be placed at a height of 4-6 feet;
- ▶ Not be next to an open door or window;
- ▶ Be in an area free from radiation contamination; and,
- ▶ Be in an area where there is free movement of air.

Following the same criteria, an outside location for collecting a background area air sample will be identified. This location should be upwind of the building and may have to be relocated if the wind is from a different direction on the day that sampling takes place. The background location will also be marked and labeled on the building diagram.

5.3 Identify Personnel on Which Personal Breathing Zone Samples will be Collected

The number of personal breathing zone samples to be collected will be calculated for each building, following the guidance provided in the Building Evaluation Checklist. Building occupants that are not routinely monitored as part of the RFETS Beryllium Control Program will be targeted for sampling. The CTR and building managers can assist with this information. Subjects from this population will be randomly selected for monitoring. If necessary, the sample population will be stratified to achieve a population representative of the entire building, minus those in the Beryllium Control Program.

After managers and supervisors have been made aware of Radian's presence in the building, selected building occupants will be approached and asked to participate. The following wording is suggested:

"Hello, my name is _____ from Radian Corporation. We are conducting an initial beryllium characterization of 35 buildings for the Kaiser-Hill Industrial Hygiene Department. As part of that study, we are collecting air samples throughout this building. Some samples are fixed location samples and others are collected from the breathing zones of people working in the building. You were randomly selected and I would like to ask if you would volunteer to wear this small sampling device today."

Once voluntary participation has been obtained, the sampling device will be placed on the person. People will be randomly selected until the prescribed number of volunteers have been secured.

5.4 Identify Tasks During Which Air Samples will be Collected

The field team leader, the building manager, and the CTR will discuss the work that is routinely conducted in the building. As the field team leader walks through the building, he will make observations of tasks that workers are conducting. The tasks that have the potential for generating airborne dust will be listed. Some examples include: floor cleaning, HVAC maintenance, equipment decontamination, structural demolition, structural repairs, equipment maintenance, furniture moving, and painting. Tasks that will be occurring on the day Radian will be collecting other area or personal air sampling will be selected, if possible. Tasks that last 1 or more hours are preferred. After notifying managers and supervisors of the sampling activities, workers will be asked if they will volunteer to participate, using statements similar to that given above.

5.5 Collect the Air Samples

The field sampling technicians will perform the air sampling. The following steps will be followed:

- 1) Set up the air sampling trains. The air sampling train consists of a battery powered vacuum pump, a length of flexible tubing, a metal adapter, and a 3-piece plastic cassette containing a 37 mm, mixed cellulose ester filter, with a 0.8 micron pore size.
- 2) Fill out the Air Sampling Field Data Sheet (Attachment 4). Attach labels to the data sheet and to the filter cassette.

3) Calibrate the sampling train with a rotometer. Area samples should be set at a flow rate of approximately 3.5 L per minute. Personal breathing zone samples should be set at a flow rate of approximately 2 L per minute. Make sure that the pump is calibrated to a flow rate that will achieve a minimum total volume of 200 L of air for the sample. Record the calibration flow rate on the field data sheet. Turn the pump off. Replace the cap on the inlet of the cassette.

4) Place the sampler in the prescribed location for an area sample. Orient the filter cassette inlet downward. For personal breathing zone samples, secure the pump to the belt of the volunteer. Provide a web belt to the volunteer if necessary. Run the flexible tubing up and over the shoulder of the volunteer. Use duct tape to secure the tubing to their back. Clip the filter cassette to the lapel. Make sure the inlet is facing downward and is not obstructed. Remove the inlet cap.

5) Turn the pump on.

6) Record the start time. Fill out any other information missing on the field sampling data sheet.

7) Check the pump periodically (about once an hour) to make sure the pump is operating properly. Record the pump checks on the field sampling data sheet. During lunch breaks, pumps may be removed from volunteers and the pump shut off. Put the inlet cap back into place when the pump is off. Put the sampling train in a secure location. Record stop and start times. Recalibration is not necessary.

8) After a minimum of 200 liters of air have passed through the filter, the sample can be terminated. For area samples this will be after about 1 hour. Personal breathing zone samples should be allowed to run for a minimum of 7.5 and preferably 8 hours. Record the stop time. Task breathing zone samples should determine when the task is completed.

9) Recalibrate the pump. Write down the final flow rate on the data sheet.

10) Remove the filter cassette from the tubing and securely replace the two caps into the inlet and outlet of the cassette. Put the filter cassette into a sealable plastic bag and seal.

11) Calculate the average flow rate and the total sample time. Multiply the two to get the total sample volume. Round to two significant digits. Record all calculations on the field data sheet.

12) Complete the sample COC. COC protocol will be in accordance with TP-ESP-501, *Manual Chain-of-Custody*.

13) Place the samples and the completed COC into a plastic sample cooler. Seal the cooler with evidence tape.

14) Decontaminate all non-disposable equipment that may have come into contact with beryllium during the collection procedure. Decontamination of sampling equipment will be conducted in accordance with TP-ESP-900, *Cleaning and Decontaminating Sample Containers and Sampling Devices*.

15) Connect the pump to the charger for overnight recharging.

5.6 Submit the Samples for Analysis

Samples will be submitted to the RFETS onsite laboratory at the end of each day. The field team leader is responsible for submitting the samples. The samples will be considered released to the laboratory when the COC is signed and the cooler relinquished. The field team leader will keep a copy of the COC after submittal. If samples cannot be submitted on the day of collection, the field team leader will maintain possession and control until they can be submitted.

6.0 QUALITY ASSURANCE AND QUALITY CONTROL

The purpose of a quality assurance/quality control (QA/QC) program is to produce data of known quality that satisfy the project objectives. The QA/QC program will provide a mechanism for ongoing control and evaluation of data quality. It will also provide a measure of data quality in terms of accuracy, precision, completeness, representativeness, and comparability to assess whether the data meet the project objectives and can be used for their intended purpose. The QA/QC program for this project includes:

- Strict observation of project-specified decontamination, sampling, and analytical procedures;
- Collection and analysis of field QC samples;
- Thorough documentation of all project activities;
- Validation of laboratory data packages at a frequency of 10% using EPA validation guidance;
- Careful and appropriate handling of sampling wastes; and
- Training and oversight of field and other project team members.

These procedures are discussed in more detail in the following sections. All cited SOPs are included in Attachment 3.

6.1 Decontamination Procedures

Decontamination procedures will be conducted in accordance with technical procedure TP-ESP-900. Decontamination of all nondisposable equipment used during the building characterization will be mandatory.

An area within each building being characterized will be designated as the decontamination area and all equipment will be decontaminated there. This area will be defined

when the building is initially evaluated. This general area will also be designated as the staging area for equipment used during the building characterization.

Following sample collection, sampling equipment such as scrapers, spatulas, screwdrivers, and other small hand tools will be subject to decontamination procedures to prevent cross-contamination. Sampling equipment will be decontaminated by the following steps:

1. Use a brush to scrub excess sample from the equipment;
2. Wash with tap water and Liquinox in a 5-gal container;
3. Rinse with tap water in a separate container;
4. Rinse with deionized water;
5. Rinse with a 5% solution of nitric acid (HNO_3);
6. Rinse with deionized water;
7. Rinse with isopropanol (optional to hasten drying);
8. Air dry; and
9. Use immediately or wrap in aluminum foil (shiny side away from equipment).

6.2 Sample Container and Preservation Requirements

Glass or plastic sample containers for standard laboratory analyses will be received precleaned by an EPA-approved method. All containers will be capped and packed in a box during shipment to the field. Containers will be stored in a clean area. Procedure TP-ESP-701 will be followed where applicable. Table 6.1 lists the types of containers and preservatives required for each analysis.

Table 6.1. Sample containers and preservation

Sample Type	Container	Preservation	Holding Time	Sample Media
Rinsate blanks	plastic or glass	5% nitric acid, $\leq 4^{\circ}\text{C}$	6 months	liquid
Surface Wipes	plastic petri dish	none	180 days	MCE filter
Air	plastic cassette	none	180 days	MCE filter
Bulk dust	plastic or glass	none	180 days	dust

MCE = Mixed Cellulose Ester

6.3 Sample Handling

The following sections describe sample handling procedures from the time of collection to the time of disposal. Samples will be handled in accordance with TP-ESP-701 and TP-ESP-800.

6.3.1 Chain-of-Custody Procedures

COC procedures that will be used are described in TP-ESP-501 and will be followed to trace possession of the samples from sample collection until data from the samples are recorded. A sample will be considered under custody if it is in the possession of the sampling team, in view of the sampling team, or transferred to a secure area. An area is considered secure only when it is locked and access is controlled.

The field team leader is responsible for custody of the samples in the field until they have been properly packaged, documented, and transferred to a courier or directly to the laboratory. If samples are not immediately transported to the analytical laboratory, they are to remain in the custody of the team leader. A COC record, included in Attachment 4, will be used for this characterization. The original COC record will accompany any samples submitted to an off-site or on-site laboratory for analysis. The laboratory will follow its own internal COC procedures, which must include the following:

- ▶ All COC forms accompanying the samples must be signed and dated upon receipt;
- ▶ Copies of the forms must be maintained as part of the final data package; and
- ▶ The laboratory must maintain an internal sample tracking system for the samples so that custody of the samples is traceable from the time they are received by the laboratory until they have been discarded.

6.3.2 Sample Labels and Custody Seals

Sample labels will be completed and affixed to all sample containers prior to or at the time of sampling. Custody seals will be used to detect tampering of individual samples shipped off site or to sample shipping containers carried to the on-site laboratory. The custody seal will be attached in such a way that it is necessary to break it in order to open the sample container. Sample labels and custody seals will include the information specified in TP-ESP-501. As an alternative to using custody seals, evidence tape with the collector's initials and date may be used. Labels and custody seals or evidence tape will be completed with black indelible ink.

6.3.3 Transportation of Samples

Most samples will be analyzed by the on-site laboratory; however, a few quality control (QC) samples will be shipped to an off-site laboratory. It is anticipated that duplicate sampling will be conducted for 10% of the samples collected and that 20% of the duplicates will be analyzed by an off-site laboratory (see Section 6.4 for further details on duplicate sampling). The on-site laboratory will ship QC samples to the off-site laboratory.

At the end of each sampling day, samples will be packaged and prepared for delivery to the on-site laboratory. Packages requiring shipment will be packaged in shipping containers as specified by the off-site laboratory and analytical protocols. An RFETS RCT will survey all samples to ensure radioactivity levels are below levels of concern for the on- and off-site laboratory personnel. Samples to be taken to the on-site laboratory will be delivered at the end of each working day whenever possible; samples will be delivered no later than one week after

collection. Samples that are not delivered at the end of the working day must be placed into a secured area as described in Section 6.3.1.

Containers to be shipped off-site will be sealed with a custody seal or evidence tape and sent to the off-site laboratory by onsite laboratory personnel. Radiological limits to meet Department of Transportation (DOT) requirements include 2.0 nCi/g for total content (~0.6% U by weight) and 1000 dpm/100 cm² surface radiation. Samples will be surveyed prior to shipment to ensure these requirements are met. All applicable DOT requirements for shipping will be met.

6.3.4 Sample Storage, Archiving, and Disposal

Once samples have been relinquished for analysis, they will not be accessible to anyone except authorized personnel. If samples cannot be analyzed the day they are delivered, they will be stored in a secure and appropriate location at the laboratory. Only approved laboratory personnel will have access to the storage area. Samples will be archived until valid data have been received, or the holding times have been exceeded. Disposal of the samples submitted for analysis will be the responsibility of the laboratory.

6.4 Field QC Samples

Field QC samples will be documented in field logbooks and submitted "blind" to the laboratory, so that the laboratory cannot distinguish between natural and QC samples during analysis. This component of the sampling program will ensure that data of known quality are produced.

6.4.1 Duplicate Samples

A field duplicate sample is a second sample collected at the same location as the original sample. Duplicate sample results are used to assess precision, including variability associated with both the laboratory analysis and the sample collection process. Duplicate samples will be collected simultaneously or in immediate succession, using identical recovery techniques, and

treated in an identical manner during storage, transportation, and analysis. Duplicate samples will be collected at a frequency of 10%. At least 20% of the duplicate samples will be submitted to the off-site laboratory for analysis. For example, if 600 samples are sent to the on-site laboratory, an additional 60 samples will be submitted as duplicates, and at least 12 will be submitted to the off-site laboratory for confirmatory analysis.

6.4.2 Field Blanks

A field blank is a sample that is handled in exactly the same manner as all other samples of that type, with the exception that the sample media is not exposed to any contaminant. Field blanks will be collected for air and wipe samples at a rate of 10%.

6.4.3 Rinsate Samples

It is anticipated that disposable equipment will be used for collection of samples. However, if reusable equipment comes in contact with sample material two equipment rinsate blanks will be collected from the decontaminated equipment for laboratory analysis. These blanks will be collected by pouring reagent grade water over decontaminated sampling equipment and allowing it to run off into sample containers. Rinsate blanks provide a measure of effectiveness of field decontamination procedures and alert project personnel to the possibility of cross-contamination.

6.5 Documentation Of Field Activities

Field documentation procedures will be in accordance with TP-ESP-400 and are described below. Copies of all documents will be kept on permanent record in Radian's Project File. Bound field logbooks and permanent, waterproof, black ink pens will be used to document the methodology, procedures, and events pertaining to sample and data acquisition. The logbooks will be considered formal documents representing a complete and organized record of all field activities. The entries will include, but are not limited to the following:

- ▶ Sample information, including:
 - sample media;
 - sample location;
 - sample identification numbers;
 - sample volume;
 - sample description;
 - date and time;
 - name of collector;
 - collection method;
 - COC information; and
 - analytical methods;
- ▶ Site conditions;
- ▶ Environmental conditions;
- ▶ Field QA/QC data;
- ▶ Model and identification numbers of field instruments used;
- ▶ Site-specific health and safety training; and
- ▶ Any other notes on characterization activities, conditions, or problems.

If an event occurs that delays sample processing, affects holding times, delays work, or negatively impacts data, it will be documented and corrective actions will be taken immediately to ensure that project objectives are met. A report detailing the event and corrective actions to be taken will be completed. The reporting process will follow the guidelines in the Radian Quality Assurance Administrative Procedure (QAAP) 16.2, as deemed appropriate by the project manager. A corrective action report will be completed with the guidance of Radian procedure QAAP 16.1.

It may be necessary during the course of this project to make changes to the procedures described in this work plan. Any such changes must be reported immediately to the project

manager and appropriately documented, and must not have a significant negative impact on project quality. All personnel involved in the work process will be informed of any changes in procedure.

Field data and field log notes will be reviewed by the team leaders on a daily basis. Prior to submission of samples to the laboratory, the field team leader will review sample COC forms with the submitted samples. The project QA officer, or her designee, will review and sign off on the field logbooks and field data at least once per week.

6.6 Laboratory Analysis

All wipe, air, and QC samples will be submitted to an on- or off-site laboratory for beryllium analysis. The following subsections summarize the analytical procedures. For more detail, the laboratory standard operating procedures (SOPs) should be consulted.

6.6.1 Analytical Procedures

The analytical procedure to be used for wipe and air samples will be the National Institute for Occupational Safety and Health (NIOSH) Method 7300, Elements by Inductively Coupled Plasma (ICP), Atomic Emission Spectroscopy (see Attachment 3). The procedure has been modified by the onsite laboratory to include mass spectroscopy (ICP-MS).

The detection limit required to meet project objectives is $0.58 \mu\text{g/wipe}$, assuming a 100 cm^2 wipe area. This detection limit is based on 60% of the level of concern (LOC) of $0.97 \mu\text{g}/100\text{-cm}^2$ ($9 \mu\text{g}/\text{ft}^2$). The lowest possible detection limit should be achieved by the analyzing laboratories because of the possibility that the LOC of $9 \mu\text{g}/\text{ft}^2$ may be reduced in the future.

The same analytical procedures used for wipe samples will also be used for air samples. However, the required detection limit for these samples will be $0.3 \mu\text{g}/\text{m}^3$. This is based on 60% of the LOC of $0.5 \mu\text{g}/\text{m}^3$. If it is assumed that the minimum quantity of air sampled for a given

filter is 200 L (see Section. 5), then the analytical detection limit must be no higher than 0.1 µg/filter. As in the case with wipe samples, the actual detection limit achieved by the laboratory should be as low as possible.

Bulk dust samples will be analyzed for particle size distribution and beryllium concentration. Phase contrast microscopy or gravimetric analysis will be used for measuring particle size. NIOSH Method 7300 will be used for determining the beryllium concentration for each particle size group. The detection limit for this analysis should be as low as reasonably possible, but small sample volume may negatively affect this.

6.6.2 Calibration Procedures

Laboratory analytical instrumentation will be controlled through a calibration program that includes the following elements:

- ▶ Each instrument or analytical measurement system must be calibrated before use; and
- ▶ Each instrument or analytical measurement system must follow the calibration procedures specified in the designated method.

In addition, the laboratory must have detailed calibration procedures in the form of an SOP, with a summary of the procedure provided in the laboratory QA plan. Standards used to calibrate an instrument or analytical measurement system must be National Institute of Standards and Testing (NIST) or EPA-traceable, and the laboratory must maintain supporting documentation.

The air sampling pumps will be calibrated before and after collection of each sample in accordance with the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Technical Manual, Second Edition (CPL 2-2.20B CH-1).

6.6.3 Analytical Turnaround Time

The turnaround time requested for preliminary results from the project laboratories is no more than 10 working days from laboratory receipt of samples. Preliminary results will be submitted immediately following analysis, prior to any laboratory data validation.

6.7 Data Quality

Sample collection and analysis will be conducted to optimize data usability. The components of data usability include precision, accuracy, completeness, representativeness, and comparability. The following paragraphs give definitions for each of these components.

Precision—Precision measures the reproducibility of repetitive measurements and is usually expressed in terms of imprecision. The overall precision of sampling during this field effort will be assessed by reviewing the results of field QC duplicate samples. Sampling precision for samples submitted to the laboratory will be expressed as the relative percent difference (RPD) for the analytical results of field QC duplicate samples. The calculation for RPD is:

$$RPD = \frac{|M - m|}{\left(\frac{M + m}{2}\right)} \times 100\%$$

where M1 and M2 are reported concentrations for each duplicate sample.

There are no specific control limits for field precision because natural heterogeneity of the environmental media usually controls the precision level. Heterogeneity may further compromise the ability to obtain a true duplicate of some samples. Wipe samples may be collected side-by-side but cannot be homogenized by ordinary means. The field team leader will visually examine the side-by-side area for collecting duplicate samples to be as homogeneous as possible. The precision goal for sampling during this effort is 25% relative difference. All the

field duplicate analytical results may be reviewed as a group to make a general conclusion about field sampling precision.

Accuracy—Accuracy is a statistical measurement of correctness, and includes components of random error (variability due to imprecision) and systematic error (bias). It therefore reflects the total error associated with a measurement. A measurement is accurate when the value reported does not differ from the true value. Accuracy will be ensured by implementing proper calibration procedures in the laboratory. Sampling accuracy will be assessed by evaluating the results of rinsate blanks, where applicable, percent recovery from spiked samples, and adequacy of detection limits.

Completeness—Completeness is calculated from the aggregation of data for the entire project. The number of valid results divided by the number of individual analyte results initially planned for, expressed as a percentage, determines the completeness for the data set. The objective for completeness is 90 percent.

Representativeness—Representativeness will be achieved through the use of standard sampling and analytical procedures as described in this plan. Representativeness will also be achieved through the use of proper sampling program design, considering elements such as sampling procedures and locations.

Comparability—Comparability is the confidence with which one data set can be compared to another. The objective for this QA/QC program is to produce data with the greatest degree of comparability possible. Comparability will be achieved by using standard methods for sampling and analysis, reporting data in standard units, and using standard and comprehensive reporting formats.

6.8 Data Validation

Data validation is the review of field measurements and analytical results against a defined set of QC criteria. Ten percent of the laboratory data will be validated to determine whether the control samples are within acceptable limits. This will be performed by the laboratory. This validation includes verifying that samples were analyzed within the proper holding times and checking that the accuracy and precision for the analytical and field results are within specified limits. The laboratory data sets will be verified against the laboratory statement of work to determine that the proper analysis was conducted on the samples and to verify that reported results are accurately transcribed and complete. The EPA validation criteria will be used as a guideline for the process. The validated laboratory data packages are signed by the reviewer with a description of the procedure used and any qualifiers pertaining to that data set.

6.9 Waste Handling

It is anticipated that the majority of waste generated as a result of the sampling effort will be non-hazardous, solid waste. All sampling waste will be segregated according to potential for contamination. The minimum amount of sampling supplies will be brought into RAD and beryllium contaminated areas in order to minimize waste volumes.

All solid waste generated by sampling and decontamination activities will be collected in heavy duty garbage bags. Liquid waste generated from decontamination procedures, estimated to be 2 to 3 gallons, will be contained in a plastic 5-gallon bucket(s) and stored in a location designated by Kaiser-Hill personnel. All waste will be properly labeled according to RFETS protocol. There will always be at least one field team member that has completed RFETS waste generator training. This will help ensure compliance with site requirements.

6.10 Personnel Training

All field personnel will receive site-specific training. This will include General Employee Radiation Training, Radiation Worker II, Beryllium Training, and Respirator Training. In

addition, building specific training will be received prior to working in that building (where applicable). Both field and office personnel who will be working with computers in support of this project (e.g., preparing reports, entering data into database) will obtain site specific computer security training.

All field personnel are expected to read and follow this plan. In addition, field personnel will receive training in the use of field procedures defined in this plan at the beginning of the project to ensure consistency of sampling. New field personnel will be trained as they are brought into the project, before they are allowed to collect samples unsupervised.